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DISTRIBUTION OF FLUORIDE IN THE GROUNDWATER IN CHANDUR AREA, NALGONGDA DISTRICT, TELENGANA, INDIA

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Abstract

This study was carried out to assess the fluoride concentration in groundwater of Chandur Mandal, Nalgonda District, where groundwater is the main source of drinking water. Water samples collected from bore wells and open wells were analyzed for pH, Electrical Conductivity (EC) and Fluoride (F^-) content. Fluoride concentration of groundwater ranges from 1.00 to 4.00 mg/l. Out of 15 samples from five villages studied 4 villages have fluoride concentration below 1 mg/l and 6 villages have fluoride concentration above 1mg/l. 5 villages have fluoride above 3 mg/l. As per the desirable and maximum permissible limit for fluoride in drinking water (1.5mg/l) prescribed by WHO (2004) and Bureau of Indian Standards (2009), 30% groundwater sources in the study area is unfit for drinking purposes. Due to the higher fluoride levels in drinking water several cases of dental and skeletal fluorosis have appeared at alarming rate in the investigated area. The wells in the investigated area have been demarcated into safe and unsafe wells for consumption of water with respect to the fluoride.
Keywords: *Fluoride, pH, EC, Groundwater, Chandur*

1. Introduction

Rapid industrialization, urbanization and population growth led to overexploitation of groundwater mostly in urban areas resulted in deterioration both in terms of quality and quantity. The importance of groundwater quality in human health attracted a great deal of interest in recent years. 80% of all diseases are related to poor drinking water and sanitary condition in developing countries (Vasanthavigar et al, 2010; UNESCO, 2006; Liebman, H. 1969). Ascertaining quality of water is crucial before its use for various intended purposes such as potable water, agricultural, recreational and industrial water uses, etc. (Sargaonkara and Deshpandev, 2003).The groundwater once gets contaminated its quality cannot be restored. Therefore it is essential to monitor the quality of groundwater and to take necessary measures to protect from further deterioration of quality. Fluoride is a key aspect of water quality in rural water supply system, which potentially affects the sustainability of water if it exceeds its prescribed limit. Approximately 62 million people including 6 million children suffer from fluorosis because of consumption of water with high fluoride concentrations (Susheela, 1999). The amount of fluoride occurring naturally in groundwater is governed by climate, composition of the host rock, and hydrogeology (Gupta et al., 2006). The major sources of fluoride in groundwater are due to fluoride bearing minerals such as fluorspar, cryolite, fluoro-apitite and

Hydroxylapatite (Sundaraiah et al., 2014). The fluoride content is a function of many factors such as availability and solubility of fluoride minerals, velocity of flowing water, temperature, pH, concentration of calcium and bicarbonate ions in water, etc. (Meenakshi et al., 2004). In Indian continent, the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks. Fluorine is the most electronegative of all chemical elements and is therefore never found in nature in elemental form.

2. Geology of study area

The study area bounded by latitude 16.97° -16.91° N and longitude 79.03° - 79.08° E and falls under Indian toposheet No 56 P/2 It is located around 100.2 kilometres away from Hyderabad.

Geologically the area of study forms a part of the Indian peninsular shield and comprises Archaean and Proterozoic formations characterised by the basement complex or the Peninsular gneissic complex rocks. The deposited in shallow basins and subsequently intruded by basic rocks are known as the Archaeans, which are the oldest formations. The gneisses and granites were subsequently intruded by dykes of dolerite and veins of pegmatite and quartz. The study area has been characterised by the rocks belonging to both Archaean and Proterozoic formations. The Proterozoic formations are also known as Cuddapah Formation. The chosen area is underlain by crystalline rocks and consists of peninsular gneissic complex i.e. pink and grey varieties of granites and granitic gneisses of Archaean age. The pink and grey granites are intruded by dolerite dykes and followed by injection of quartz, feldspar, pegmatite and epidote veins. Dolerite dykes mark the last period of igneous activity. There have also recent alluvial deposits in the area. They are confined to the valleys between the hill ranges as valley fill deposits and the flood plains of Hallia and Konagal rivers and also to the narrow thin patches along the streams.

The study area belongs to the Nalgonda district located in the NW of Cuddapah super group, these rocks majorly comprising basement granite and dolerite dyke occur in parts of Chandur, Udathalapally, Gundrapally, Chamalapally and Pochampally villages in the western part of the district and in the parts of Chandur mandal (Fig 1). Ground water occurs under water table conditions in the intergranular secondary pores of weathered rocks. The area consists of Basic Dykes, Grey Granite and weathered part of Sediments. In shales and phyllites the depth of weathered zone varies between 3 and 15m bgl and the well depths range between 4 to 17m bgl and the depth to water levels range between 2 to 16m bgl and yields of wells are generally less than 30 m^3 /day. The rock types and minerals occurred regionally as granite, dolerite dykes at Chandur, Dolerite which exist at Gundrapally and Udathalpally villages.

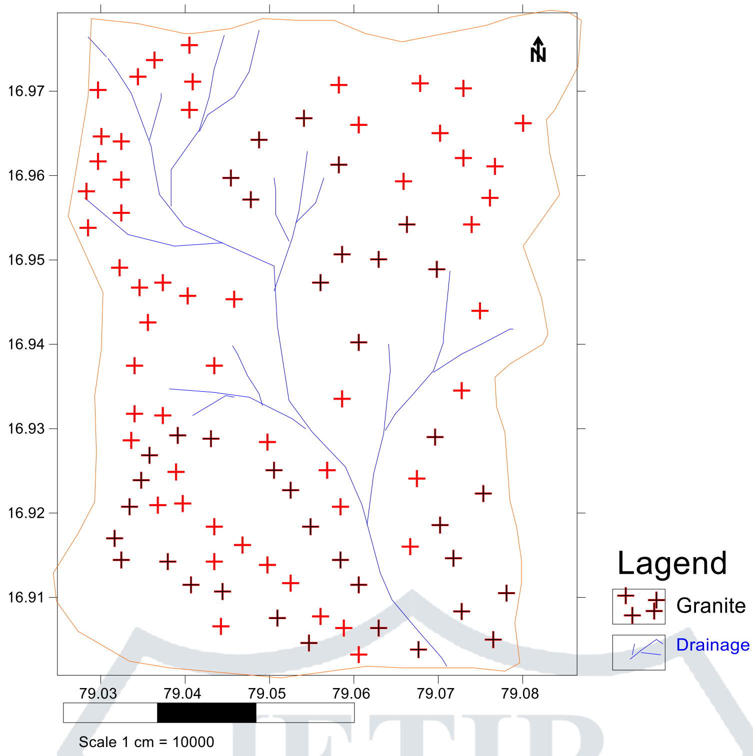

Fig 1 Geological map of the study area

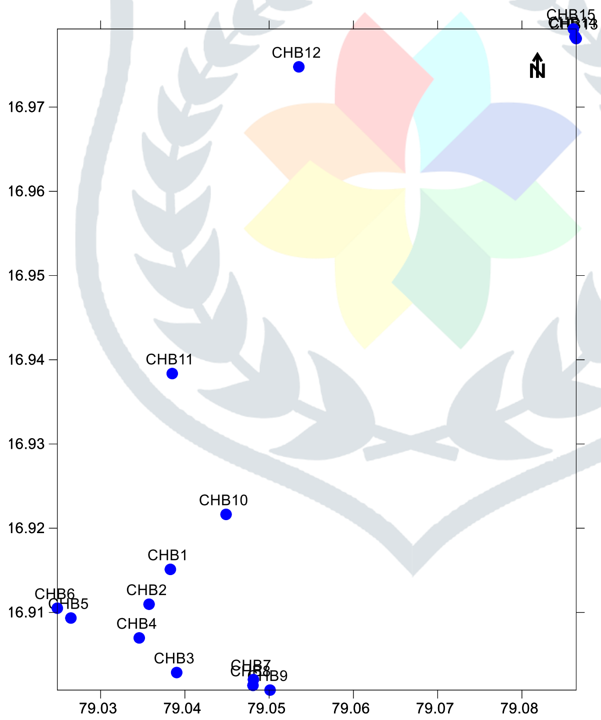

Fig 2 Sample Location map of study area

3. Hydrogeology

Geologically, the area consists of granites, dolerites rocks of Archaean age in Cuddapah basin. The granites are brown and major grey in color, hard massive to foliated and jointed. The soil cover is of well-developed residual soil of weathered granite. The soil is reddish-black in colour. The soil is fairly permeable and the infiltration rate can absorb most of the rain except for more intensive rains, which can cause considerable surface flow and erosion (Environ Horton, R. K. 1965; Man Harkins, R. D. 1974; Oldenburg et al 2001;

Hamdyet al., 2005; Machender et al. 2013 & 2014). Groundwater occurs in the soil of weathered granite, semi-weathered and fractured hard under the water table and in semi-confined conditions. The average depth of groundwater is about 10–12 m. These rocks possess negligible primary porosity but due to secondary porosity by deep fracturing and weathering, they are rendered with a porosity and permeability, which locally form potential aquifers in study area (CGWB, 2007).

4. Materials and Methods

In order to achieve the research objective, groundwater samples from study area were collected from 15 different locations in 500 ml polyethylene bottles. All the sampling bottles were soaked with 1:1 HNO3 and rinsed using double distilled water. At the time of sampling, sampling bottles were thoroughly rinsed two or three times using the groundwater to be sampled. In case of bore wells, groundwater samples were collected after pumping for sufficient time. Electrical conductivity (EC in μS/cm) and hydrogen-ion activity (pH) of groundwater samples were measured in the field with the use of digital portable metes. TDS (total dissolved solids) was calculated using the formula, TDS (mg/l) = EC (μS/cm) × 0.64. The results were evaluated in accordance with the drinking water quality standards given by the World Health Organization (2004) and Bureau of Indian Standards (2009). The pH was measured with Digital pH Meter (Model 802 Systronics), EC was measured with Conductivity Meter (Model 304 Systronics), and Fluoride concentration was measured with Orion ion analyzer with fluoride ion selective electrode (ISE). The concentration of EC is expressed in microsiemens/cm at 25ºC, and Fluoride(F-) are expressed in mg /l. Location map of the water sample is shown in the (Fig.2), the analytical results are presented in the (Tables 1).

5. Results and Discussions

pH

The pH of water is a very important indication of its quality and provides important information in many types of geochemical equilibrium or solubility calculation (Hem, 1985). The present investigation area of pH is varying from 7.6 to 8.1 with an average value is 7.8 respectively. The pH of groundwater in the study area is moderately alkaline (pH more than 7) in nature. Higher alkalinity of groundwater activates leaching of fluoride and thus increases concentration of fluoride ions in groundwater (Wodeyar and Sreenivasan, 1996; Subba Rao, 2003; Jacks et al., 2005; Kodata et al., 2007 and Tiwari et al., 2008), it was observed in high fluoride reported areas.

Electrical Conductivity (EC)

Electrical conductivity of the groundwater varies from 392 to 1120 micromhos/cm at 250C (average 774.11 micromhos/ cm). The acceptable limit of EC in drinking water is less than 1500 micromhos/cm (WHO, 2004; BIS, 2009). All the sampling stations show concentrations less than the prescribed limit.

Fluoride

Concentration in the groundwater of study area varies from 1.00 to 4.00 mg/l with an average of 2.17. After evaluating the data it is suggested that groundwater of some samples namely CHB-3, CHB-5, CHB-6, CHB-9 and CHB-14 are recorded above 3mg/l, few sampling stations are recorded as above the 2mg/l i.e. CHB-1, CHB-2, CHB-10, CHB-11, CHB-13 and CHB-15, rest of the samples were recorded as 1.00 mg/l.

Table 1 Hydrogeochemical Analysis results

Sample No	pH	EC	F^-
CHB-1	8	392	2
CHB-2	7.9	616	2
CHB-3	7.8	1120	3
CHB-4	7.9	728	1
CHB-5	8.1	448	4
CHB-6	7.8	1120	3
CHB-7	7.6	1120	1
CHB-8	8	952	1
CHB-9	7.9	1008	3
CHB-10	7.9	448	2
CHB-11	7.8	448	2
CHB-12	7.8	728	1
CHB-13	7.9	896	2
CHB-14	7.9	1008	3
CHB-15	8.1	616	2
Min	7.6	392	1
Max	8.1	1120	4
Avg	7.8	774.11	2.176

Conclusions

Hydrogeochemical investigations carried out in the Chandur mandal SW part of Nalgonda district reveals that the most of the groundwater is alkaline in nature. Groundwater of the study area shows concentrations less than the prescribed limit of 1500 micromhos/cm of EC and suitable for drinking purpose While 30% of groundwater sampling stations i.e. CHB-3, CHB-5, CHB-6, CHB-9 and CHB-14 shows excess fluoride prescribed for drinking purpose. It is observed that the people living in high fluoride concentration areas are suffering from mottled teeth and also knee joint pains especially in younger people. It is attributed to the migration of fluoride from anthropogenic sources during rainy season. Moreover, dental and skeletal fluorosis is at alarming stage in local resident of Chandur and surrounding areas.

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